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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:		
Applicants:	:	Constantine J. Tsikos et al.
Serial No.	:	10/730,481
Filing Date	:	December 8, 2003
Title of Invention	:	METHOD OF AND SYSTEM FOR ACQUIRING AND ANALYZING INFORMATION ABOUT THE PHYSICAL ATTRIBUTES OF OBJECTS USING PLANAR LASER ILLUMINATION BEAMS, VELOCITY-DRIVEN AUTO-FOCUSING AND AUTO-ZOOM IMAGING OPTICS, AND HEIGHT AND VELOCITY CONTROLLED IMAGE DETECTION ARRAYS
Examiner	:	n/a
Group Art Unit	:	2876
Attorney Docket No.	:	108-103USANA0

Honorable Commissioner of Patents
and Trademarks
Washington, DC 20231

INFORMATION DISCLOSURE STATEMENT UNDER 37 C.F.R. 1.97

Sir:

In order to fulfill Applicants' continuing obligation of candor and good faith as set forth in 37 C.F.R. 1.56, Applicants submit herewith an Information Disclosure Statement prepared in accordance with 37 C.F.R Sections 1.97, 1.98 and 1.99.

The disclosures enclosed herewith are as follows:

U.S. PUBLICATIONS

NUMBER	FILING DATE	TITLE
6,429,931	January 11, 2002	METHOD AND APPARATUS FOR ARTICLE INSPECTION INCLUDING SPECKLE REDUCTION
6,369,888	November 17, 1999	METHOD AND APPARATUS FOR ARTICLE INSPECTION INCLUDING SPECKLE REDUCTION
6,367,935	October 12, 1999	METHOD AND DEVICE FOR ELIMINATING IMAGE SPECKLES IN SCANNING LASER IMAGE PROJECTION

6,304,373	March 9, 1998	IMAGING SYSTEM USING MULTI-MODE LASER ILLUMINATION TO ENHANCE IMAGE QUALITY
6,294,793	December 3, 1992	HIGH SPEED OPTICAL INSPECTION APPARATUS FOR A TRANSPARENT DISK USING GAUSSIAN DISTRIBUTION ANALYSIS AND METHOD THEREFOR
6,262,432	December 3, 1992	HIGH SPEED SURFACE INSPECTION OPTICAL APPARATUS FOR A REFLECTIVE DISK USING GAUSSIAN DISTRIBUTION ANALYSIS AND METHOD THEREFOR
6,230,975 B1	October 7, 1999	OPTICAL READER WITH ADAPTIVE EXPOSURE CONTROL
6,223,988 B1	October 14, 1997	HAND-HELD BAR CODE READER WITH LASER SCANNING AND 2D IMAGE CAPTURE
6,191,887 B1	January 7, 2000	LASER ILLUMINATION WITH SPECKLE REDUCTION
6,184,981 B1	March 26, 1999	SPECKLE MITIGATION FOR COHERENT DETECTION EMPLOYING A WIDE BAND SIGNAL
6,159,153	December 31, 1998	METHODS AND SYSTEMS FOR ULTRASOUND SCANNING USING SPATIALLY AND SPECTRALLY SEPARATED TRANSMIT ULTRASOUND BEAMS
6,128,049	January 29, 1999	USE OF SHUTTER TO CONTROL THE ILLUMINATION PERIOD IN A FERROELECTRIC LIQUID CRYSTAL-BASED SPATIAL LIGHT MODULATOR DISPLAY DEVICE
6,081,381	October 26, 1998	APPARATUS AND METHOD FOR REDUCING SPATIAL COHERENCE AND FOR IMPROVING UNIFORMITY OF A LIGHT BEAM EMITTED FROM A COHERENT LIGHT SOURCE

Re: 36,528	March 24, 1995	OPTICAL SCANNING HEAD
5,988,506	June 16, 1996	SYSTEM AND METHOD FOR READING AND DECODING TWO DIMENSIONAL CODES OF HIGH DENSITY
5,986,745	March 24, 1997	CO-PLANAR ELECTOMAGNETIC PROFILE SCANNER
5,841,889	December 29, 1995	ULTRASOUND IMAGE TEXTURE CONTROL USING ADAPTIVE SPECKLE CONTROL ALGORITHM
5,825,803	December 14, 1995	MULTIPLE EMITTER LASER DIODE ASSEMBLY WITH GRADED-INDEX FIBER MICROLENS
5,786,582	December 8, 1995	OPTICAL SCANNER FOR READING AND DECODING ONE- AND TWO DIMENSIONAL SYMBOLOGIES AT VARIABLE DEPTHS OF FIELD
5,710,417	June 2, 1995	BAR CODE READER FOR READING BOTH ONE DIMENSIONAL AND TWO DIMENSIONAL SYMBOLOGIES WITH PROGRAMMABLE RESOLUTION
5,672,858	June 30, 1994	APPARATUS AND METHOD FOR READING INDICIA USING CHARGE COUPLED DEVICE AND SCANNING LASER BEAM TECHNOLOGY
5,621,203	June 30, 1994	METHOD AND APPARATUS FOR READING TWO-DIMENSIONAL BAR CODE SYMBOLS WITH AN ELONGATED LASER LINE
5,615,003	November 29, 1994	ELECTROMAGNETIC PROFILE SCANNER
5,565,667	May 16, 1995	SYSTEM AND PROCESS FOR READING HOLOGRAM CODE, HOLOGRAM AND CARD CONTAINING HOLOGRAM
5,545,886	July 29, 1993	BARCODE SCANNER USING AN ARRAY OF LIGHT EMITTING ELEMENTS

		WHICH ARE SELECTIVELY ACTIVATED
5,532,467	July 2, 1996	OPTICAL SCANNING HEAD
Re. 35,148	January 20, 1995	FREQUENCY DIVERSITY FOR IMAGE ENHANCEMENT
5,378,883	July 19, 1991	OMNIDIRECTIONAL WIDE-RANGE HAND HELD BAR CODE READER
5,319,185	July 24, 1992	SMALL-SIZE HAND-SUPPORTED BAR CODE READER
5,319,181	March 16, 1992	METHOD AND APPARATUS FOR DECODING TWO-DIMENSIONAL BAR CODE USING CCD/CMD CAMERA
5,258,605	April 6, 1992	SCAN GENERATORS FOR BAR CODE READER USING LINEAR ARRAY OF LASERS
5,212,390	May 4, 1992	LEAD INSPECTION METHOD USING A PLANE OF LIGHT FOR PRODUCING REFLECTED LEAD IMAGES
5,192,856	November 19, 1990	AUTO FOCUSING BAR CODE READER
5,136,145	August 28, 1990	SYMBOL READER
4,979,815	February 17, 1989	LASER RANGE IMAGING SYSTEM BASED ON PROJECTIVE GEOMETRY
4,961,195	August 3, 1988	SYSTEMS FOR CONTROLLING THE INTENSITY VARIATIONS IN A LASER BEAM AND FOR FREQUENCY CONVERSION THEREOF
4,900,907	March 18, 1987	OPTICAL INFORMATION READING APPARATUS
4,826,299	January 30, 1987	LINEAR DEIVERGING LENS
4,820,006	May 12, 1983	HOLOGRAPHIC IDENTIFICATION SYSTEM USING INCOHERENT LIGHT
4,687,325	March 28, 1985	THREE-DIMENSIONAL RANGE CAMERA

3,901,597	September 13, 1973	LASER DISTANCE MEASURING DEVICE

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NUMBER	PUBLICATION DATE	TITLE
WO 01/71419 A2	September 27, 2001	LARGE DEPTH OF FIELD LINE SCAN CAMERA
WO 01/72028 A1	September 27, 2001	COPLANAR CAMERA SCANNING SYSTEM
WO 00/65401	November 2, 2000	MECHANICALLY OSCILLATED PROJECTION DISPLAY
WO 00/62114	October 19, 2000	METHOD AND DEVICE FOR REDUCING THE FORMATION OF SPECKLE ON A PROJECTION SCREEN
WO 00/43822	July 27, 2000	LASER ILLUMINATION WITH SPECKLE REDUCTION
60/190,273	May 29, 2001	COPLANAR CAMERA
WO 99/64980	December 16, 1999	IMAGING ENGINE AND METHOD FOR CODE READERS
WO 99/64916	December 16, 1999	ILLUMINATION TECHNIQUES FOR OVERCOMING SPECKLE ARTIFACTS IN METROLOGY APPLICATIONS
WO 99/60443	November 25, 1999	LASER PROJECTION APPARATUS WITH LIQUID-CRYSTAL LIGHT VALVES AND SCANNING READING BEAM
WO 99/49787	October 7, 1999	ULTRASONIC CAMERA
WO 99/31531	June 24, 1999	SCATTER NOISE REDUCTION IN HOLOGRAPHIC STORAGE SYSTEMS BY SPECKLE AVERAGING
WO 99/21252	April 29, 1999	FILAMENTED MULTI-WAVELENGTH VERTICAL-CAVITY SURFACE

TECHNICAL PUBLICATIONS

Web-based publication entitled "AV3700 Coplanar Illumination Option" by Accu-Sort Systems, Inc., www.accusort.com/products/coplanar.html, 1 page.

Web-based Product Brochure on Model 120 LIVAAR Short Wave IR Gated Camera Specification, by Intevac Corporation, Santa Clara CA, September 2001, pages 1-2.

Web-based presentation entitled "NEW LIVAR IMAGERY" by Intevac Corporation, Santa Clara CA, http://www.intevac.com/livar_imagery/livar_imagery.html. 2001, pages 1-9.

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Product Brochure for the Lasiris™ SNF Laser by StockerYale, Salem NH, 2001, pages 1-4.

Academic publication entitled "Nonlinear Electro-Optic Effect and Kerr Shutter" by Jagat Shakya and Mim lal Nakarmi, Dept. of Physics, Kansas State Univ., April 2001, pages 1-14.

Product Brochure for the AV3700 High Speed CCD Bar Code Reader by Accu-Sort Corporation, 2001, pages 1-2

Chapter 4 entitled "Speckle Reduction" by T.S. McKechnie, Topics in Applied Physics Vol. 9 - Laser Speckle and Related Phenomena, Editor J.C. Dainty, Springer-Verlag, 1984, pages 123-170.

Product brochure for DALSA IT-PA Image Sensors, by Dalsa, Inc., 2001pages 1-14.

Web-based brochure for the Optical Shutter by Optron Systems, Inc., http://members.bellatlantic.net/-optron3/shutter.htm#TypicalApplications, 2001, pages 1-4.

Product Specification for "KAF-4202 SERIES Full-Frame CCD Image Sensor Performance Specification" by Eastman Kodak Company, Rochester NY, June 29, 2000, pages 1-15.

User Manual for the Piranha CT-P4, CL-P4 High Speed Line Scan Camera by Dalsa, Inc., 2000, pages 1-30.

Scientific publication entitled "Speckle Reduction in Laser Projections with Ultrasonic Waves" by Wang et al., Opt. Eng. 39(6) 1659-1664 June 2000, Vol. 39, No. 6.

Scientific publication entitled "Principles of Parametric Temporal Imaging - Part I: System Configurations" by Bennett et al., IEEE Journal of Quantum Electronics, Vol. 36, No. 4, April, 2000, Vol. 36, No. 4, pages 430-437.

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Scientific publication entitled "The Use of Diode Laser Collimators for Targeting 3-D Objects" by Clarke et al., Dept. Engineering/City Univ./London, 1994, pages 47-54.

Scientific publication entitled "Speckle Reduction by Virtual Spatial Coherence" by Freischlad et al., SPIE Vol. 1755 Interferometry: Techniques and Analysis (1992), pages 38-43.

INTERNATIONAL SEARCH REPORTS

App. No.	Filing Date
PCT/US01/44011	August 6, 2002

STATEMENT OF PERTINENCE

U.S. Patent No. 6,369,888 to Karpol et al. discloses a method and apparatus for reducing speckle during inspection of articles used in the manufacture of semiconductor devices, including wafers, masks, photomasks, and reticles. The coherence of a light beam output by a coherent light source, such as a pulsed laser, is reduced by disposing elements in a light path. Examples of such elements include optical fiber bundles; optical light guides; optical gratings; an integrating sphere; and an acousto-optic modulator. These various elements may be combined as desired, such that light beams output by the element combinations have optical path length differences that are greater than a coherence length of the light beam output by the coherent light source.

U.S. Patent No. 6,367,935 to Wang et al. discloses a method for the elimination of image speckles in a scanning laser projection, in which a phase hologram is used for dividing the illumination beam of the projector into partial beams. The partial beams are heterodyned again on the image screen within the image element (pixels) to be projected in such a way that differing speckle patterns are formed which average each other out in the eye of the viewer over time and/or space. Thus, a device is provided especially for the laser projection which substantially eliminates or reduces the speckles at the viewer. However, the beam form and the beam density are hardly or not changed.

U.S. Patent No. 6,429,931 to Karpol et al. discloses a method and apparatus for reducing speckle during inspection of articles used in the manufacture of semiconductor devices, including wafers, masks, photomasks, and reticles. The coherence of a light beam output by a coherent light source, such as a pulsed laser, is reduced by disposing elements in a light path. Examples of such elements include optical fiber bundles; optical light guides; optical gratings; an integrating sphere; and an acousto-optic modulator. These various elements may be combined as desired, such that light beams output by the element combinations have optical path length differences that are greater than a coherence length of the light beam output by the coherent light source.

U.S. Patent No. 6,304,373 to Zavislan discloses an imaging system using multi-mode laser illumination to enhance the quality of image produced by confocal microscopy, and especially scanning laser confocal microscopy, especially for images obtained in turbid mediums such as many biological tissue specimens, by reducing speckle from scatterers that exist outside the section which is being imaged by utilizing reduced coherence illumination, such as provided by a multi-mode laser. The laser beam is focused to provide its intensity in lobes forming offset spots in opposite (180°) amplitude phase relationship. The lobes are combined in the return light from the section and detected after passing through the confocal aperture of the confocal microscope. Images can be formed from the detected return light. Light from scatterers outside the section of interest, which are illuminated by both of the lobes beams overlap outside the section and

interfere, thereby reducing speckle due to such scatterers, and particularly scatters which are adjacent to the section being imaged.

U.S. Patent No. 6,294,793 to Brunfeld et al. discloses an optical inspection apparatus which operates at high speed at very high resolution for detecting defects in transparent disks in a production environment. These transparent disks are of the type commonly used as disk platters in hard disk drives. This apparatus uses a laser beam directed to a polygon scanner, which provides a linear scan of the beam along a radius of the disk. The disk to be inspected is rotated such that its entire surface passes the scan path of the laser beam. The laser beam, after passing through the unit to be inspected, is directed to a parallel detector array, which detects changes in the nominal Gaussian distribution of the laser beam that correspond to defects in the surface of the transparent disk above a programmable threshold level. This parallel detection method allows the inspection apparatus to identify defects much smaller than the diffraction limits of the optics used, and will accurately identify changes of the laser beam caused by defects in the disk. An automatic disk handler loads untested disks into the apparatus and unloads and sorts tested disks according to the results of the inspection.

U.S. Patent No. 6,262,432 to Brunfeld et al. discloses an optical inspection apparatus which operates at high speed at very high resolution for detecting defects in reflective disks in a production environment. These reflective disks are of the type commonly used as disk platters in hard disk drives. This apparatus uses a laser which provides a light beam directed to a polygon scanner, which provides a linear scan of the beam along a radius on both sides of the disk by using two mirrors to direct the light beam. The disk to be inspected is rotated such that its entire surface passes the scan path of the light beam. The light beam is reflected off the reflective disk, and returns to the scanning optics and the polygon scanner in a path coincident with the transmitted light beam. The reflected light beam is distinguished from the transmitted light beam by using a beam splitter to direct the reflected light beam to a parallel detector array, which detects changes in the nominal Gaussian distribution of the light beam that correspond to defects in the surface of the reflective disk above a programmable threshold level. This parallel detection method allows the inspection apparatus to identify defects much smaller than the diffraction limits of the optics used, and will accurately identify changes in the light beam caused by defects in the disk. An automatic disk handler loads untested disks into the apparatus and unloads and sorts tested disks according to the results of the inspection.

U.S. Patent No. 6,230,975 B1 to Colley et al. discloses an optical or symbol reader including CMOS circuitry preferably integrated on a single chip. A CMOS optical reader chip comprises a CMOS imaging array having a plurality of pixels each with a dedicated pixel-site circuit. Charge is accumulated at each pixel location transferred upon demand to a common bus. In a preferred embodiment, exposure time of the imaging array is controlled using a feedback loop. One or more exposure control pixels are positioned adjacent to or within the imaging array and receive light along with the imaging array. The charge of the exposure control pixel or pixels is measured against a threshold level, and the amount of time taken to reach the threshold level determines the time exposure of the pixels of the imaging array. CMOS signal processing circuitry is employed which, in combination with the exposure control circuitry, minimizes time-to-read over a large range of light levels, while performing spatially optimal filtering. Clocking cycles and control signals are time-adjusted in accordance with the varying output frequency of the imaging array so as to provide invariant frequency response by the signal processing circuitry.

A multi-dimensional CMOS imaging array is also provided having simultaneous pixel exposure with non-destructive readout of the pixel contents.

U.S. Patent No. 6,223,988 B1 to Batterman et al. discloses a hand-held bar code reader which includes a laser scanning module and a two dimensional image sensor and processor for reading a bar code. The laser scanner assists the 2D image processing by providing information on location, type, range, reflectivity, and presence of bar code for 2D reading. Additionally, the 2D image reading operation is improved by using the laser scan as a spotter beam for aiming.

U.S. Patent No. 6,191,887 B1 to Michaloski et al. discloses a speckle reduction system which divides pulses of coherent radiation into successions of temporally separated and spatially aberrated pulselets. One or more beamsplitters divide the pulses into the successions of pulselets that are circulated through delay lines. Spatial aberrators located along the delay lines modify wavefront shapes of the pulselets. Together, the temporal separation and spatial aberration of the pulselets produce a succession of different speckle patterns that can be averaged together within the integration interval of a detector to reduce speckle contrast.

U.S. Patent No. 6,184,981 B1 to Hasson et al. discloses multiple independent spectral measurements of light reflected from a target which are produced concurrently by illuminating the target with a train of laser pulses wherein the train of pulses produces a line spectrum within the illuminating signal. A characteristic dimension of the receiving aperture is established based on illuminating wavelength, a cross-sectional dimension of illuminated region of a target, and the range between a target and the receiving aperture or image plane. The characteristic dimension corresponds to the spacing of peaks in a speckle pattern of an image plane. The use of multiple receiving telescopes having the characteristic dimension allows for independent measurements concurrently by each of the receiving telescopes. The train of illuminating pulses is generated by mode-locked operation of the laser for synchronization of sinusoidal components at line frequencies of the pulse train spectrum, and wherein the spacing of the spectral lines is at least a decorrelation frequency. The number of spectral lines preferably equals the number of independent measurements concurrently attainable during reception of the reflected pulse train. Alternatively, the laser frequency may be linearly swept such that the overall bandwidth is equal to the bandwidth encompassed by the line spectrum of the generated pulse.

U.S. Patent No. 6,159,153 to Dubberstein et al. discloses multiple transmit ultrasound beams which are generated by an ultrasound transducer at different frequencies in different directions in a region of a body during a maximum scan range interval. Transmitting multiple transmit ultrasound beams during the maximum scan range interval may provide an increase in the data acquisition rate compared to conventional ultrasound imaging systems. The transmit ultrasound beams are tracked using parallel receive processing and filtered to provide ultrasound scan lines for display. The respective directions of the transmit ultrasound beams are selected to define a separation angle therebetween which may reduce interference between the transmit ultrasound beams. The maximum scan range interval includes a time interval from a first start time to a second start time which is less than a total time for one of the transmit ultrasound beams to propagate to a maximum scan range in the region and a corresponding reflected transmit ultrasound beam to propagate from the maximum scan range to the ultrasound transducer. The ultrasound scan lines are displayed using a line-by-line frequency interlace pattern which may reduce the effect of frequency dependent attenuation in the region. The line-by-line frequency

interlacing may also reduce a difference in speckle size due to the different frequencies.

U.S. Patent No. 6,128,049 to Butterworth discloses a ferroelectric liquid crystal-based display device comprising a light source, a reflective spatial light modulator, a light output, a beam splitter, and a shutter to control the illumination period in the display device. The beam splitter is located and aligned relative to the light source, the light output, and the spatial light modulator such that light generated by the light source is reflected or transmitted towards the spatial light modulator, and then light reflected by the spatial light modulator is reflected or transmitted towards the light output. The shutter has both an OPEN and a CLOSED state, and may include ferroelectric liquid crystal material. The shutter may be located and aligned relative to the light source and the beam splitter such that when OPEN it transmits the light generated by the light source towards the beam splitter, and when CLOSED it prevents transmission of the light generated by the light source towards the beam splitter. Alternatively, the shutter may be located and aligned relative to the light output and the beam splitter such that when OPEN it transmits the light reflected by the spatial light modulator towards the light output, and when CLOSED it prevents transmission of the light reflected by the spatial light modulator towards the light output.

U.S. Patent No. 6,081,381 to Shalapenok et al. discloses a method and apparatus for elimination of speckle pattern in optical system by reducing coherence. The invention is based on the use of a rotating microlens array having a rotational speed chosen with reference to laser parameter. For a continuous laser this relationship consists in that the exposure time is sufficient for overlapping at least 10,000 spot sizes of the speckle. For a pulse laser, the laser pulse time should be sufficient for shifting the speckle spot at least by the magnitude of its diameter. Several embodiments with modified coherence reduction units are available. One modified embodiment describes a rotating inclined plate which enhances coherence reduction by scanning over the surface of the diffuser. Another embodiment describes the use of an optical conical rod with total internal reflection for creation of a plurality of non-coherent light sources.

U.S. Patent No. RE. 36,528 to Roustaei discloses the design for a bar code scanner using the Light Emitting Diode (LED), Optical Scanner assembly and Charge-Coupled Devices (CCD) capable of reading the barcode symbols at the variable distance. An optical passive elements for increasing the depth of field and a method of fabricating the scanning head by mass-production techniques are also disclosed.

U.S. Patent No. 5,988,506 to Schaham et al. discloses a system for reading two dimensional codes as well as regular bar codes. A laser scanner generates a narrow horizontal beam which scans a code by means of a scanning mirror in the vertical direction. This mirror receives the reflected beam and passes it on to the lens array to yield high quality imaging characteristics all across a large field of view angle. The lens array and an auto focusing system produce images of the scanning lines in the sensor plane - a CCD linear array. In the sensor's plane, sub aperture diaphragms generate partially overlapping fields of view from each of the elements of the lens array. The system electronics converts the CCD linear array electrical signals into digital data. A module synthesizes in real-time the partially overlapping line sections of the image signal into an integrated continuous line signal and stores them consecutively in the image memory. A system processor operates an autofocus, as well as code classification and decoding algorithms.

U.S. Patent No. 5,986,745 to Hermary et al. discloses a co-planar system for determining the shape and dimensions of a surface of an object which includes a projector for projecting a spatially coded pattern of radiation, e.g., light, in a selected plane onto the object. The system also includes a receiving device capable of imaging the reflected pattern in the selected plane, and a discriminator for determining which portion of the reflected pattern corresponds to which portion of the projected pattern. By this means, a received signal representing less than the complete reflection from the projected pattern can be correlated with a discrete portion of the scanned object. The object is moved relative to the selected plane and the procedure repeated to obtain enough reliable data to generate a reasonably reliable surface profile. The resulting set of received signals and correlations are used to calculate the shape and dimensions of the object.

U.S. Patent No. 5,841,889 to Seyed-Bolorforosh discloses a method for controlling the contrast resolution and the tissue texture of ultrasonic images which employs a signal processing algorithm to adjust an image by changing the tissue texture (speckle grain size). The algorithm increases the image contrast by allocating a different speckle pattern to different grey scale levels. This signal processing algorithm is based on the Hilbert transform. It uses the property of the Hilbert transform to generate a quadrature component of the given image which is modulated by the speckle pattern as well as all other image information. The quadrature component is then squared before being selectively added to or subtracted from the square of the in-phase component of the given image to control the information in the image. The added or subtracted signals have different textures (or spatial frequency components). The arithmetic operation between the in-phase and quadrature phase components determines the image texture. If this operation is done selectively, then the contrast and the texture of the image can be selectively controlled.

U.S. Patent No. 5,825,803 to Labranche et al. discloses a multiple emitters laser diode assembly which comprises a laser diode bar for emitting a laser beam. Th laser diode bar comprises a plurality of emitters aligned with respect to each other in a same plane of emission. A graded-index elongated fiber microlens is transversely set at a given distance in front of the laser diode bar for controlling the divergence of the beam. The microlens has an axis of symmetry substantially intersecting the optical axis of each emitter. A mount is provided for positioning the microlens with respect to the laser diode bar. Alternatively, the assembly may comprise a laser diode array for emitting the beam. The laser diode array comprises a plurality of substantially parallel rows of emitters with a substantially regular period between them. An array of graded-index elongated fiber microlenses is positioned substantially parallel to the rows. Each microlens corresponds to one of the rows for collimating the beam generated thereby. The GRIN fiber microlens shows less alignment sensitivity than ordinary fiber lens or aspherical fiber lens when used in a multiple emitters laser diode assembly. The GRIN lens further has the advantage of collimating a laser diode bar or array with a high degree of quality while minimizing phase aberration and distortion in the collimated transmitted beam.

U.S. Patent No. 5,786,582 to Roustaei et al. discloses an optical device for reading one- and two-dimensional symbologies at variable depths of field, the device including a light source for projecting an emitted light beam towards the two-dimensional image and an optical assembly, or zoom lens, with dual field of view capability for focusing light reflected from the framed symbology onto a CCD detector for detecting the focused light and generating a signal therefrom. The dual field of view capability enables scanning of both wide and narrow fields of view. An apodizing filter is provided within the optical assembly to increase depth of field. Aiming of the

sensor to read the symbology is facilitated by a frame locator including a laser diode which emits a beam that is modified by optics, including diffractive optics, to divide the beam into beamlets having a spacing therebetween that expands to match the dimensions of the field of view of the sensor, forming points of light at the target to define the edges of the field of view. One or two sets of diffractive optics may be provided, with one set corresponding to each position, for each of the dual field of view positions of the zoom lens.

U.S. Letters Patent No. 5,710,417 to Joseph et al. discloses hand-held linear images, in which a plurality of the areas of differing light reflectivity of a bar code symbol or the like which are simultaneously illuminated using, for example, a beam of light that has an elongated cross-section. The light beam is swept over the symbol to be read in a direction transverse to the elongated dimension of the illuminated region so that a two-dimensional area of the symbol is illuminated over time. The reflected light is sensed by a 1D CCD array. A microprocessor within the scanner provides visual feedback to aid a user in aligning the device, and also provides for a selectable aspect ratio for the image, a selectable image resolution and size, a selectable aspect ratio of the illumination, and a selectable pixel size. All of these options may be programmed within the microprocessor, enabling the device to read a large variety of two-dimensional symbols.

U.S. Patent No. 5,672,858 to Li et al. discloses a scanning device for reading indicia of differing light reflectivity, including bar code or matrix array symbols, which has a single light emitter, such as a laser or light emitting diode, for generating a scanning light beam to visually illuminate sequential portions of the indicia. A sensor, such as a charge coupled device (CCD) or other solid state imaging device, simultaneously detects light reflected from portions of the indicia and generates an electrical signal representative of the spatial intensity variations of the portions of the indicia. The scanning device may also include an ambient light sensor, and a second light emitter for use only in aiming or orienting the scanning device. A photodetector may also be provided to separately detect one symbol virtually simultaneous with the detection of another symbol by the sensor or to provide dual modalities. A method for reading indicia is also provided.

U.S. Patent No. 5,621,203 to Swartz et al. discloses a plurality of the areas of different light reflectivity of a bar code symbol, or the like, which are simultaneously illuminated using, e.g., a beam of laser light that has an elongated cross-section. The laser light beam is swept over the symbol in a direction transverse to the elongated dimension of the illuminated region so that a two-dimensional area of the symbol is illuminated over time, until the symbol is read. The light that reflects from the illuminated region of the symbol is imaged on a linear sensor array, which is then scanned or read out to produce signals representative of spatial intensity variations of the imaged light along a linear path in the field of view.

U.S. Patent No. 5,615,003 to Hermary et al. discloses a system for determining the shape and dimensions of a surface of an object which includes a projector for projecting onto the object a spatially coded pattern radiation, e.g., light. The system also includes a receiving device capable of imaging the reflected pattern, and a discriminator for determining which portions of the reflected pattern corresponds to which portion of the projected pattern. By this means, a received signal representing less than the complete reflection from the projected pattern can be correlated with a discrete portion of the scanned object. The procedure is repeated to obtain enough reliable data to generate a reasonably reliable surface profile. The resulting set of received signals and correlations are used to calculate the shape and dimensions of the object.

U.S. Patent No. 5,565,667 to Takahashi et al. discloses a hologram code reading system wherein the reconstruction light of a light source illuminates the recorded area of a hologram that contains codified data recorded as image data, and a code reading sensor is arranged at the reconstruction position of the hologram reconstruction image played back by the reconstruction light from the light source, and a control means is provided for obtaining codified data from the hologram reconstruction image readout by the code reading sensor.

U.S. Patent No. 5,545,886 to Metlitsky et al. discloses a bar code scanner which employs an electronic means for causing the light beam to scan a bar code symbol, rather than using a mechanical device to generate the scan. A linear array of light sources, activated one at a time in a regular sequence, may be imaged upon the bar code symbol to simulate a scanned beam. Instead of a single linear array of light sources, a multiple-line array may be employed, producing multiple scan lines. The multiple scan lines may be activated in sequence, or activated simultaneously (time-division or frequency-division multiplexed. The multiple scan lines can provide signal enhancement, noise reduction or fault correction if directed to the same bar code pattern. Multiple scan lines may be generated using a single light source and a beam splitter, with mechanical scanning, as well as by the sequentially-activated light sources. Multiple simultaneous scan lines may be employed to generate a raster scan at lower mechanical scan frequency. In another embodiment, a tunable laser may be employed to provide a scan without moving parts; a laser beam from the tunable laser is reflected from a diffraction grating that produces an angular deviation dependent upon the wavelength of the laser output. As the frequency of the tunable laser is varied in some selected pattern, the laser beam will scan accordingly.

U.S. Patent No. 5,532,467 to Roustaei discloses an optical scanning head which includes at least one trio of light emitting diodes arranged so the LEDs emit light at different angles to create a fan of light. An optical module includes a light shield or "dark room" and a lens/filter assembly which provides control of the depth of focus of the scanner. The optical module is located behind the light source, and the detector, made up of a CCD array is mounted behind the optic module for detecting the light intensity in the reflected beam over a field of view across a bar code symbol. The CCD array generates an electrical signal indicative of the detected light intensity. A DC source or battery provides DC voltage to the LEDs and CCDs in response to a clocked signal which provides a gradual or sequential illumination of the LEDs and coordinates the activation of the CCDs in order to minimize power consumption during scans.

U.S. Patent No. Re. 35,148 to Lizzi et al. discloses methods for improving the availability of information derived from signals received from an object irradiated with coherent pulses of any form of radiation that exhibits a wave nature. A method for reducing speckle derives separate component noncoherent signals from the received signals, and combines these separate noncoherent signals to form improved composite noncoherent signals. Weighting and processing of component signals can be applied as a function of time, frequency, and signal amplitude to optimize speckle reduction in all or a critical part of the signal by compensating for the range and frequency dependence of attenuation and the frequency dependence of scattering phenomena. In a method for enhancing resolution, separate component coherent signals are derived from the received signals, weighted and processed, and combined to form improved composite coherent signals; then noncoherent signals are derived from the improved composite coherent signals. In both methods, signals can be processed either in the analog or digital domains or in hybrid

analog/digital domains. Apparatus for performing each method is also disclosed.

U.S. Patent No. 5,378,883 to Batterman et al. discloses a hand-held bar code reader with a two dimensional image sensor for omnidirectional bar code reading, which includes variable imaging optics, and flash illumination with variable flash illumination optics. A spotter beam is provided for aiming the hand held bar code reader at a bar code symbol. The spotter beam is also used to measure the range to said bar code from said hand held bar code reader and to determine the focal length of said variable imaging optics and variable flash illumination optics. The imaging optics are adjusted automatically to provide the correct magnification and focus of a bar code regardless of range to the label. The variable focal length flash illumination optics are used to concentrate illumination energy only in the field of view of the bar code reader. The flash illumination energy is conserved by measuring the ambient light and setting the level of flash illumination energy in accordance with the measured level of ambient light. In such a manner, conventional, damaged, multiple, and stacked bar code symbols along with true two dimensional codes may be rapidly read over distances from under one foot to over several feet without having to align the bar code reader to the bar code.

U.S. Patent No. 5,319,185 to Obata discloses a bar code reader which has a sensor unit to be mounted on an operator's finger and a decoder unit to be mounted on an operator's wrist, the sensor and decoder units being electrically connected by a cable. The sensor unit has a light-emitting device for emitting light toward a bar code to be read, a graded-index rod lens array for focusing an entire linear optical image of the bar code at one time in substantially the same size as the bar code, and a line image sensor such as a CCD for photoelectrically converting the entire linear optical image focused by the optical means into an electric signal. The decoder unit decodes the electric signal from the line image sensor. The light-emitting device, the rod lens array, and the line image sensor are housed in a hollow casing. A movable tubular member is movably disposed in the hollow casing and has an end wall for abutment against the bar code. A switch for energizing the light-emitting device and the decoder unit is fixedly mounted in the hollow casing and triggerable by the movable tubular member when the movable tubular member is moved by abutment of the end wall thereof against the bar code.

U.S. Patent No. 5,319,181 to Shellhammer et al. discloses a method and apparatus for decoding a two-dimensional bar code symbol using a charge-coupled device (CCD) camera or a charge-modulation device (CMD) camera. The CCD/CMD camera takes pictures of the symbol and the picture is converted into digital data. The location and orientation of the two-dimensional bar code symbol is determined and verified. Defects and damages on the symbol are detected and corrected. The symbol is scanned to read the codewords of the two-dimensional bar code symbol.

U.S. Patent No. 5,258,605 to Metlitsky et al. discloses a bar code scanner which employs an electronic means for causing the light beam to scan a bar code symbol, rather than using a mechanical device to generate the scan. A linear array of light sources, activated one at a time in a regular sequence, may be imaged upon the bar code symbol to simulate a scanned beam. Instead of a single linear array of light sources, a multiple-line array may be employed, producing multiple scan lines. The multiple scan lines may be activated in sequence, or activated simultaneously (time-division or frequency-division multiplexed. The multiple scan lines can provide signal enhancement, noise reduction or fault correction if directed to the same bar code pattern. Multiple scan lines may be generated using a single light source and a beam splitter, with mechanical

scanning, as well as by the sequentially-activated light sources. Multiple simultaneous scan ines may be employed to generate a raster scan at lower mechanical scan frequency. In another embodiment, a tunable laser may be employed to provide a scan without moving parts; a laser beam from the tunable laser is reflected from a diffraction grating that produces an angular deviation dependent upon the wavelength of the laser output. As the frequency of the tunable laser is varied in some selected pattern, the laser beam will scan accordingly.

U.S. Patent No. 5,212,390 to LeBeau et al. discloses a device which employs a laser diode and cylindrical lens to project a plane of laser at an incidence angle onto a plurality of leads. The light is simultaneously reflected from each of the plurality of leads. The light that is simultaneously reflected from each lead is detected by an image sensor. A digital computer computes the cotangent function of the incidence angle to detect an amount of displacement of at least one of the plurality of leads.

U.S. Patent No. 5,192,856 to Schaham discloses in Fig. 1 a hand-held imaging device for reading and interpreting bar codes which illuminates the bar code with a fixed elliptical light beam (produced by an LED and collimating and cylindrical lens), and images the reflected beam onto a linear CCD array which is aligned with the light beam. The black and white bar information is detected by the electronically scanned elements of a linear CCD array. The limited operational range, determined by the optical system depth of focus, is enhanced significantly to a useful operational range by automatically focusing the image of the bar code on the CCD array.

U.S. Patent No. 5,136,145 to Karney discloses a symbol reader that uses a dynamic random access memory as a detector element and a gradient refractive index material as the lens to capture a symbol image. The rod shaped lens passes through an opaque cover and confronts the array of memory elements in the memory. The cover is glued to a memory device package. The PN junctions of the random access memory are activated by light reflected from a symbol and appear as data when the random access memory is read out. The light can be provided by light emitting diodes positioned adjacent to the memory package and in a handheld wand that includes a light reflecting shield in which the symbol is positioned for reading. The wand is positioned over the symbol and a read button is depressed. A computer monitoring the read button activates the light emitting diodes and then reads out the contents of the random access memory, unscrambles the data, signals the user that the symbol has been captured and then outputs the symbol image.

U.S. Patent No. 4,979,815 to Tsikos discloses a range imaging system, and a method for calibrating such a system which are based on the principles of projective geometry. The system comprises four subsystems: (1) a laser and a cylindrical lens or vibrating mirror for producing a planar beam of light; (2) an electronic camera equipped with a lens and an appropriate interference filter; (3) an electronic circuit for height (depth) measurements and video image generation; and (4) a scanning mechanism for moving the object with respect to the light beam and the camera so as to scan an area of the object surface. The system is calibrated by determining the position in the electronic image of the object surface at three different heights. The range image is generated from these three known heights from either a previously determined look-up table, or from a calculation based on the invariance of the cross-ratio, a well known ratio from projective geometry.

U.S. Patent No. 4,961,195 to Skupsky et al. discloses a system for controlling the intensity

of broad-band laser pulse beam so that its intensity varies uniformly and provides uniform illumination of a target.

U.S. Patent No. 4,900,907 to Matusima et al. discloses a handheld reader for reading optical information such as a bar code contains a reading sensor. An image of the optical information is imaged by light produced by a pair of LEDs and reflected from the optical information, via a reflecting mirror, a lens and a diaphram member, onto the reading sensor so that the image is converted into an electric signal. The pair of LEDs are disposed on both sides of the image sensor so that the images thereof are imaged near the optical information by light from the LEDs through the diaphram member, the lens and the reflecting mirror. The LEDs and reading sensor are controlled so that the LEDs are disabled from emitting light while the reading sensor performs the reading operation of the optical information.

U.S. Patent No. 4,826,299 to Powell discloses a lens which has the appearance of a prism with a relatively sharp radius at the apex. This lens finds an application in expanding a laser beam in one direction only.

U.S. Patent No. 4,820,006 to Constant discloses an apparatus and method for a holographic identification system used to determine the presence and identification of objects with tags and labels placed on persons, articles, goods, merchandise, documents, credit cards, identification cards and the like. The apparatus comprises holographic means for encoding and decoding tags and labels with ordinary incoherent light. The method comprises the steps of holographically encoding tags and labels, attaching labels to objects, and holographically decoding tags and labels wherein the encoding and decoding is done with incoherent light.

U.S. Patent No. 4,687,325 to Corby, Jr. discloses a three-dimensional range camera system which measures distance from a reference plane to many remote points on the surface of an object. The set of points at which range is measured lie along a straight line (N points) or are distributed over a rectangular plane (MxN points). The system is comprised of a pattern generator to produce a 1xN array of time/space coded light rays, optionally a means such as a rotating mirror to sweep the coded light rays orthogonally by steps, a linear array camera to image subsets of the light rays incident on the object surface, and a high speed range processor to determine depth by analyzing one-dimensional scan signals. The range camera output is a one-dimensional profile or a two-dimensional area range map, typically for inspection and robotic vision applications.

U.S. Patent No. 3,901,597 to White discloses a laser distance measuring device. When a diffusely reflecting surface, such as the kind ordinarily encountered on the most physical objects, is located in the focal saddle of a lens, the combination produces reflection that has spatial coherence characteristics similar to those obtained from a specular surface. Such a combination can be employed in conjunction with a conventional mirror to provide a low-Q Fabry-Perot resonant cavity. A high gain laser medium can produce oscillation with such a low-Q resonator. When the diffuse surface is outside the lens focal saddle the cavity Q is too low and laser action will not occur. As the focal saddle is advanced toward the surface, the cavity Q will increase and the onset of laser oscillation will signal contact between the focal saddle and the surface. This contact position is repeatable to high precision and is therefore a useful distance measurement. In one alternative embodiment the active laser medium is not contained within the low-Q cavity but instead the low-Q cavity is optically coupled to a conventional laser and its optical length

modulated at a convenient frequency. If the laser output is examined for modulation components at the cavity modulation frequency, contact between the focal saddle and the diffuse surface can be established by their presence. In a second alternative embodiment the low-Q cavity includes a quarter-wave plate and is optically coupled to a dual polarization laser having greater than critical adjacent mode coupling. Such a laser will oscillate in only one mode at a time but two orthogonal polarization states are permitted. When the low-Q cavity is operative, that is, when the diffuse surface is inside the lens focal saddle, moving the surface relative to the lens will cause the laser polarization state to flip for each quarter wave length of motion. Thus if the laser polarization state is monitored, entry of the surface into the focal saddle can be sensed by the onset of polarization flipping and motion inside the focal saddle can be established by counting the number of flips.

WIPO Publication No. WO 01/71419 A2 by Accu-sort Systems, Inc., discloses a scanning system which utilizes a randomly addressable image sensor which is selectively positioned at the Scheimpflug angle in the image plane in order to detect focused light reflected from an object. Light reflected from the object is focused onto the sensor through an objective lens. Since the sensor is mounted at the Scheimpflug angle, each strip within the depth of field of the object plane has corresponding pixels on the sensors which are in focus.

WIPO Publication No. WO 01/2028 A1 by Accu-sort Systems, Inc., discloses a system for scanning objects having a linear array sensor, adapted to detect light input signals. A lens is optically connected to the linear array sensor, and is adapted to receive and transmit an optical image located in a field of view along a lens axis to the linear array sensor. A light source which generates an illumination stripe in general linear alignment with the lens axis is provided. A cylindrical lens is positioned between the light source and an object to be scanned. The cylindrical lens adapted to collect, transmit and focus light from the light source to form the illumination stripe.

WIPO Publication No. WO 00/65401 by Intel Corporation discloses a projection display system which may be mechanically perturbed to remove or reduce speckle noise in displayed images. In addition, pixellation effects may also be removed or reduced. By mechanically disturbing a portion of the system, for example using a wobble perturbation, the speckle effects may be temporarily smeared so that they become invisible to the user. In one embodiment, a folding mirror may be mechanically perturbed, using a plurality of piezoelectric actuators, at frequencies in the ultrasonic range.

WIPO Publication No. WO 00/62114 by Deutsche Telekom discloses a method and a device for reducing the speckle noise that is formed on a projection display when a coherent light source is used. Before being projected, the light coming from the light source strikes an electrically controllable optical element with a spatially inhomogeneous index of refraction and penetrates said optical element, whereby the index of refraction within the period of projection is temporally altered. This leads to the averaging out of the speckle pattern on the projection screen. A multimode light source is preferably used for illumination and/or the light coming from the light source is split into several spatial modes in order to increase the effect. The light from the light source is preferably split by being coupled into a multimode light-conducting fiber. Said optical element is advantageously a liquid crystal element consisting of at least two liquid crystal layers, to which a position-dependent voltage is applied in order to produce a position-dependent index of

refraction and whose birefringence is compensated by the appropriate alignment of the layers in relation to each other.

WIPO Publication No. WO 00/43822 by Tropel Corporation discloses a speckle noise reduction system which divides pulses of coherent radiation into successions of temporally separated and spatially aberrated pulselets. One or more beam splitters divide the pulses into the succession of pulselets that are circulated through delay lines. Spatial aberrators located along the delay lines modify wavefront shapes of the pulselets. Together, the temporal separation and spatial aberration of the pulselets produce a succession of different speckle patterns that can be averaged together within the integration interval of a detector to reduce speckle contrast.

U.S. Provisional Application No. 60/190,273 by Chaleff et al. publishes as WIPO International Publication No. WO 01/72028 A1, discloses an optical scanning system containing a coplanar camera utilizing a LED array light source and a linear CCD sensor array.

WIPO Publication No. WO 99/64980 by Symbol Technologies, Inc. discloses an imaging engine and signal processing devices and methods for reading various kinds of optical codes. The compact structure (54") may include a two-dimensional image sensor, apparatus for focusing images at different focal disclosures, a laser-beam type aiming system, a hi-low beam illumination system employing an array of LEDs on lenslet plate (50), and related signal processing circuits.

WIPO Publication No. WO 99/64916 by Optimet, Optical Metrology Ltd., discloses a method and apparatus for converting a beam of light that is substantially coherent and has a coherence length into substantially incoherent radiation so as to overcome speckle artifacts in Metrology Applications. The method has the steps of collimating the beam, delaying a first portion of the beam by a first optical delay by ballistic passage through a first cell of an optical element, and delaying each of a plurality of other portions of the beam by an optical delay different from the first optical delay by an amount exceeding the coherence length of the beam.

WIPO Publication No. WO 99/60443 by Troyer discloses a laser projection apparatus that projects laser lines at 635 nm or longer which are preferred for red, giving energy-efficient, bright rapid-motion images with rich, full film-comparable colors. Green and blue lines are used too - and cyan retained for best color mixing, an extra light-power boost, and aid in speckle suppression. Speckle is suppressed through beam-path displacement - by deflecting the beam during projection, thereby avoiding both absorption and diffusion of the beam while preserving pseudocollimation (noncrossing rays). The latter in turn is important to infinite sharpness. Path displacement is achieved by scanning the beam on the liquid-crystal valves (LCLVs), which also provides several enhancements - in energy efficiency, brightness, contrast, beam uniformity (by suppressing both laser-mode ripple and artifacts), and convenient beam-turning to transfer the beam between apparatus tiers.

WIPO Publication No. WO 99/49787 by Lockheed Martin IR Imaging Systems, Inc., discloses an ultrasonic camera having a high efficiency ultrasonic lens which is coupled to an ultrasonic transmitter/receiver by a stretched membrane interface. The ultrasonic lens provides highly efficient transmission of ultrasound without introducing aberrations. The ultrasound system also uses a quasi-incoherent source to reduce speckle noise in the image.

WIPO Publication No. WO 99/31531 by Northrop Grumman Corporation discloses a method and apparatus for increasing detection signal-to-noise ratio, while reading out a hologram from a holographic storage medium. The hologram is written by interfering a write reference beam with an object beam. The method comprises the steps of (1) effecting multiple sequential hologram-read operations using multiple read reference beams separated from each other by a separation angle; (2) shifting the detector array contents in between hologram-read operations such that the data signal patterns incident on the detector array are approximately identical but the incident scatter noise patterns are uncorrelated; and (3) integrating the multiple hologram readouts electronically on the detector array so as to reduce scatter noise by speckle averaging. The apparatus comprises a laser source, a beamsteerer, a detector array and a shifting device.

WIPO Publication No. WO 99/21252 by Honeywell, Inc. describes a Vertical-Cavity surface Emitting Laser (VCSEL) for producing a filamented light output. In a preferred embodiment, this is accomplished by providing a number of discrete objects that are positioned adjacent to or within one or both of the cladding mirrors, or within the active region itself. The discrete objects may alter the reflectance, current injection and/or gain of the VCSEL at corresponding discrete locations, thereby causing the filamented light output. Besides providing a filamented output, the VCSEL operates at a low drive current, provides high performance, and occupies less physical area than a broad-area (wide aperture) VCSEL. Thus, the VCSEL has a number of advantages provided by a conventional laser including speed, efficiency and power, but does not suffer from many of the disadvantages of high coherence. The utilization of speckle averaging within multi-mode fiber interconnections and CD-like spatial imaging applications are contemplated.

The web-based publication for the "AV3700 Coplanar Illumination Option" by Accu-Sort Systems, Inc. describes coplanar lighting technology that concentrates critical light on the target surface in the linear read area. This concentrated illumination feature allows high-speed, high-resolution image capture using a low-power LED light source. Coplanar LED illumination eliminates the mounting angle between the line of sight of the camera and the light source. This maximizes the return light and allows for a lower intensity light source.

The Intevac Product Brochure for the Model 120 LIVAR Short Wave IR Gated Camera describes a range-gated, laser-illuminated, two-dimensional imaging system that operates in the "eye-safe" wavelength band.

The web-based publication for the Intevac New LIVAR Imagery system (http:www.intevac.com/livar_imagery/livar_imagery.html) exhibits the Laser Illuminated Viewing and Ranging (LIVAR) system which is designed for range-gated imaging in the 1.5um band.

The web-based publication entitled "Planar Etalon Theory" by TecOptics, Inc. describes the equation of the transmission of an ideal etalon.

The web-based publication entitled "Types of Planar Etalons and Typical Specifications" by TecOptics describes the various types of planar etalons, including Air-Spaced Etalons, Solid Etalons, MicroEtalons, and Deposited Etalons, as well as Ultra-Narrow Tuned Etalon Filters.

The scientific publication entitled "High-Speed, Repetitively Pulsed Ruby Laser Light

Source" by Physical Sciences Inc. describes the development of a high-repetition rate, multi-pulsed ruby laser as a light source for high-speed events. This red light laser incorporates repetitive Q-switching technology to achieve high individual pulse energies sufficient to overcome the self-luminosity of a supersonic bow shock.

The website for INO, Inc.'s "Collimated Laser Diode Arrays" describes laser diode arrays which are collimated using microlens collimation technology. Microlens collimation increases the laser diode array brightness by more than two orders of magnitude. Beam divergence depends on laser array size and is typically 2.0* x1.0* FWHM for large, high-density multi-bar arrays but can be nearly diffraction-limited for single-bar arrays. The highly diverging "fast" axis is collimated using a proprietary GRIN cylindrical microlens array and the "slow" axis is collimated using a plano-convex cylidndrical mocrolens array. These microlens arrays are permanently attached to the laser array assembly and are mechanically robust and insensitive to vibration and temperature variations.

The StockerYale Product Brochure for the Lasiris™ SNF Laser describes Lasiris™ SNF beam shaping optics which transforms the familiar laser dot into different shapes and sizes. For example, a straight line can be projected by allowing one dimension of light to fan out while maintaining tight control over the other, resulting in a sheet-of light. This laser system incorporates an optical line generator that eliminates gaussian distribution of the light.

The scientific publication entitled "Nonlinear Electro-Optic Effect and Kerr Shutter" by Shakya et al. describes the production of Kerr Electro-Optic effect for light shuttering application, including optical communication where the rate of optical pulse (data) transfer is of great importance.

The Accu-Sort Product Brochure for the AV3700 High Speed CCD Bar Code Reader describes a CCD camera that can be mounted over the belt or for side- and bottom-read applications. A new low-power, high-intensity LED-based illumination option, which can be used with the AV3700 Reader, offers the same image quality and read rate performance as the standard sodium vapor lamps, and eliminates glare for side and bottom reading.

Chapter 4 of Topics in Applied Physics entitled "Speckle Reduction" by T.S. McKechnie, describes several different methods of reducing speckle noise and the four basic categories under which these methods fall: 1) speckle reduction by illuminating with temporally partially coherent light; 2) speckle reduction by illuminating with spatially partially coherent light; 3) speckle reduction in the time-average while moving an aperture; and 4) speckle reduction by observing the speckle pattern through a finite aperture.

The DALSA, Inc. Product Brochure for the DALSA IT-P4 Image Sensors describe the Dalsa IT-P4 sensor as having feature 4096, 6144, or 8192 elements and using proprietary technology to provide four outputs at 40MHz each. The DALSA IT-P4 Image Sensor employs buried channel CCD shift registers to maximize output speed and reduce noise. The IT-P4 sensor has a dynamic range of >1600:1 and a linear dependence on light level up to saturation. The exposure control of the IT-P4 sensor allows integration times shorter than the readout time.

The web-based publication for Optron Systems, Inc. "Optical Shutter" describes the

MMLS system which consists of (1) a large-aperture, high-speed, electrically-addressed MMLS, (2) a high-voltage (75 V) high-bandwidth (100 kHz) drive-signal waveform amplifier, and (3) spatial filtering readout optics. The shutter can tolerate high optical power, and offers amplitude or phase modulation of light. The light may be coherent or incoherent, polarized or unpolarized, and may cover a broad wavelength range. Typical driving voltage waveforms include pulses, square waves, sine waves, ramps, and arbitrary shapes.

The Eastman Kodak Company Product Brochure for the KAF-4202 Series Full-Frame CCD Image Sensor describes a high performance monochrome area CCD image sensor with 2032 H x 2044V photo active pixels designed for a wide range of image sensing applications in the 0.4 nm to 1.0 nm wavelength band. Typical applications include military, scientific, and industrial imaging. A 74dB dynamic range is possible operating at room temperature.

The Camera User's Manual for the DALSA Piranha CT-P4, CL-P4 High-Speed Line-Scan Camera describes a modular camera which uses the reliability, flexibility, and cost-effectiveness of high-volume interchangeable parts. Within the Piranha camera, a timing board (PB-P1-X206) generates all internal timing and a driver board (PB-P1-X139) provides bias voltages and clocks to the CCD image sensor. For enhanced dynamic range, one or two A/D board (PB-xx-D344) process the video and digitize it to 10 bits before outputting the most significant 8 bits.

The scientific article entitled "Speckle reduction in laser projections with ultrasonic waves" (Optical Engineer 39, June 2000) discloses a way to eliminate speckles in the far field by modulating a laser beam with traveling ultrasonic waves in a liquid cell. The resulting running interference fringes in a pixel on the screen will produce a boiling speckle pattern, which will be time-averaged in the eye of the observer. By superposition of ultrasonic waves of different frequencies, the speckle contrast can be reduced even further. The intensity modulation depth of the speckle pattern could be reduced to a few percent without noticeable influence on the beam quality.

The scientific publication entitled "Principles of Parametric Temporal Imaging - Part I: System Configurations" describes the recently developed process of temporal imaging which expands or compresses time waveforms while preserving the shapes of their envelope profiles. A key element in a temporal imaging system is a time lens which imparts a quadratic phase modulation to the waveform being imaged. Several methods, such as electro-optic modulation, can be used to produce the phase modulation. In this paper, we concentrate on the parametric mixing of a signal waveform with a linearly chirped optical pump as the time lens mechanism. We analyze all single-lens system configurations including sum- and difference-frequency mixing schemes with positive and negative group velocity dispersions using temporal ray diagrams as an aid in understanding their operation.

The Sony Product Brochure for the ICX085AL Progressive Scan CCD Image Sensor Chip describes a 2/3-inch interline CCD solid-state image sensor with a square pixel array. Progressive scan allows all pixel signals to be output independently within approximately 1/12 second. This sensor chip features an electronic shutter with variable charge-storage time which makes it possible to realize full-frame still image without a mechanical shutter. High sensitivity and low dark current are achieved through the adoption of HAD (Hole-Accumulation Diode) sensors.

The Mitsubishi Product Brochure for the ML1XX6 series laser diodes describes a high power AlGalnP semiconductor laser which provides a stable, single transverse mode oscillation with emission wavelength of 658-nm and standard CW light output of 30mW.

The NEC Press Release entitled "NEC Develops Highly Stable, Ultra-short Pulse Semiconductor Laser for Ultra-high Capacity Optical Communications" discloses the development of a pico-second pulse emission, ultra-high capacity optical communications semiconductor laser with precision control of signal wavelength and frequency. The semiconductor laser can emit a wavelength controlled ultra-short light pulse at a frequency of 10 gigahertz (SDH frequency) for optical communications with complete stability. The monolithic integrated device, mode-locked laser diode consists of several key functions. Integrated in the device are a pulse-forming non-linear saturable absorber section (SA section); and optical pulse stabilizing electro-absorptive light modulator section (EA section); a wavelength controlling distributed Bragg reflector section (DBR section); and a quantum well optical gain section for light amplification at 1.55-micron wavelength.

The scientific publication entitled High-speed visualization, a powerful diagnostic tool for microactuators - retrospect and prospect" by Krehl et al. describes the use of test microactuators to characterize the output parameters, provide kinematic and temperature data for a revaluation of numerical modeling, ensure the expected response with the macroscopic world, and study the mechanism of a premature failure.

The article entitled "Laser triangulation: fundamental uncertainty in distance measurement" by Dorsch et al. discusses the uncertainty limit in distance sensing by laser triangulation. The uncertainty in distance measurement of laser triangulation sensors and other coherent sensors is limited by speckle noise. Speckle arises because of the coherent illumination in combination with rough surfaces. A minimum limit on the distance uncertainty is derived through speckle statistics. This uncertainty is a function of wavelength, observation aperture, and speckle contrast in the spot image. Surprisingly, it is the same distance uncertainty obtained from a single-photon experiment and from Heisenberg's uncertainty principle. An uncertainty principle connecting lateral resolution and distance uncertainty is introduced. Design criteria for a sensor with minimum distance uncertainty are determined: small temporal coherence, small spatial coherence, a large observation aperture.

The scientific publication entitled "The Use of Diode Laser Collimators for Targeting 3-D Objects" by Clarke et al. describes the theory of speckle, the magnitude of the location error due to speckle, and methods which can minimize or remove the effect of speckle.

The (1992) SPIE publication entitled "Speckle reduction by virtual spatial coherence" by Freischlad et al. describes a technique developed to reduce the effects of speckles in the laser interferometer DIRECT 100 by a virtual reduction of the spatial coherence regarding the speckle contrast. In the technique presented here the direction of the illuminating light beam in the interferometer is modulated while averaging wavefronts (not intensities) with the real-time wavefront averaging capability of DIRECT 100, resulting in a virtually larger extent of the light source. The fringe contrast is independent of this beam modulation, whereas the speckle contrast in the accumulated wavefront is determined by the virtual extent of the light source. Thus speckle effects not only from the imaging part of the optical train, but also from the illuminating part, are

reduced.

TecOptics Corporation's web-based presentation entitled "Introduction: Fabry-Perot Etalon Technology" describes the different types of Fabry-Perot Etalon technology available laser line narrowing, laser monitoring, astronomy, UV microlithography, optical communications, remote sensing, and a myriad of other industrial and research applications. These different types include Air-Spaced Etalons, Solid Etalons, Micro-Etalons, and Deposited Etalons.

A separate listing of the above references on PTO Form 1449 and a compact disc containing copies of these references in .pdf format are enclosed herewith for the convenience of the Examiner.

The requisite fee of $180.00 is enclosed herewith as Thomas J. Perkowski, Esq., PC Check No. 4756 in the same amount. The Commissioner hereby authorized to charge any fee deficiencies or credit any overpayments to Deposit Account No. 16-1340.

Respectfully submitted,

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INFORMATION DISCLOSURE STATEMENT BY APPLICANTS

Sheet	1	of	8

Complete If Known	
Application Number	10/730,481
Filing Date	December 8, 2003
First Name Inventor	Constantine Tsikos et al.
Group Art Unit	2876
Examiner Name	N/a
Attorney Docket Number	108-103USANA0

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		2002 Search Report for International Application No. PCT/US01/44011

EXAMINER **DATE CONSIDERED**

EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance not considered. Include copy of this form with next communication to applicant.

(INFORMATION DISCLOSURE STATEMENT – SECTION 9 PTO-1449)